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Path towards operational use of recent ALARO microphysics developments

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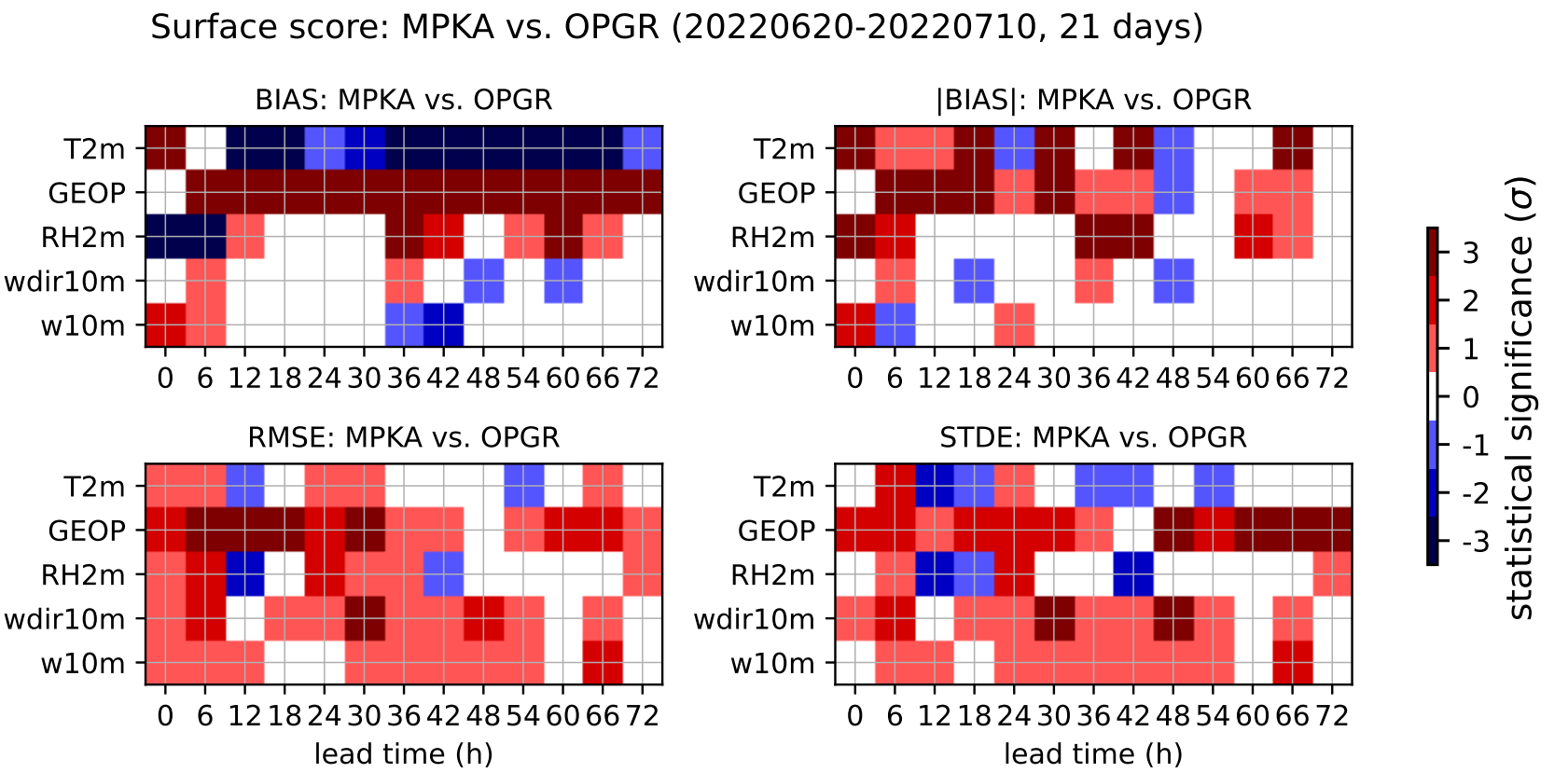
Microphysics changes in last year's presentation

- mainly Lopez evaporation instead of Kessler one
- minor autoconversion changes

...its last slide :(

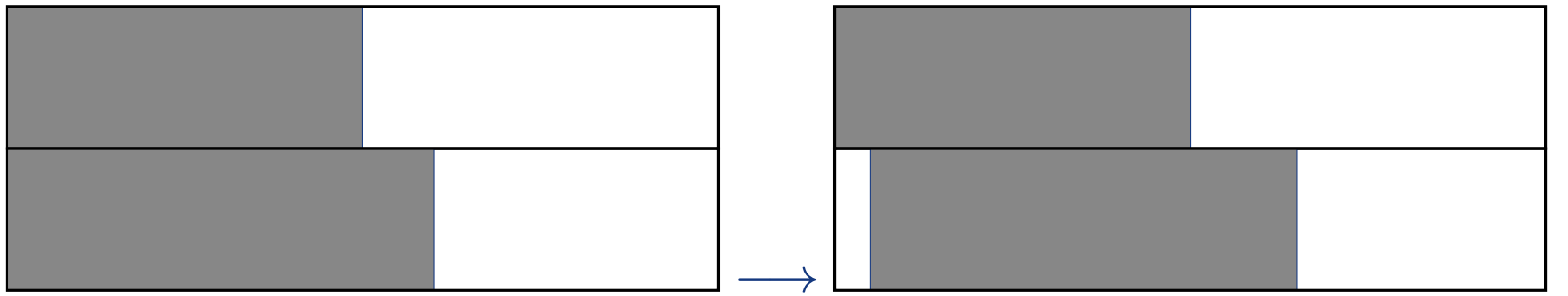


Why we would like to have Lopez evaporation scheme?

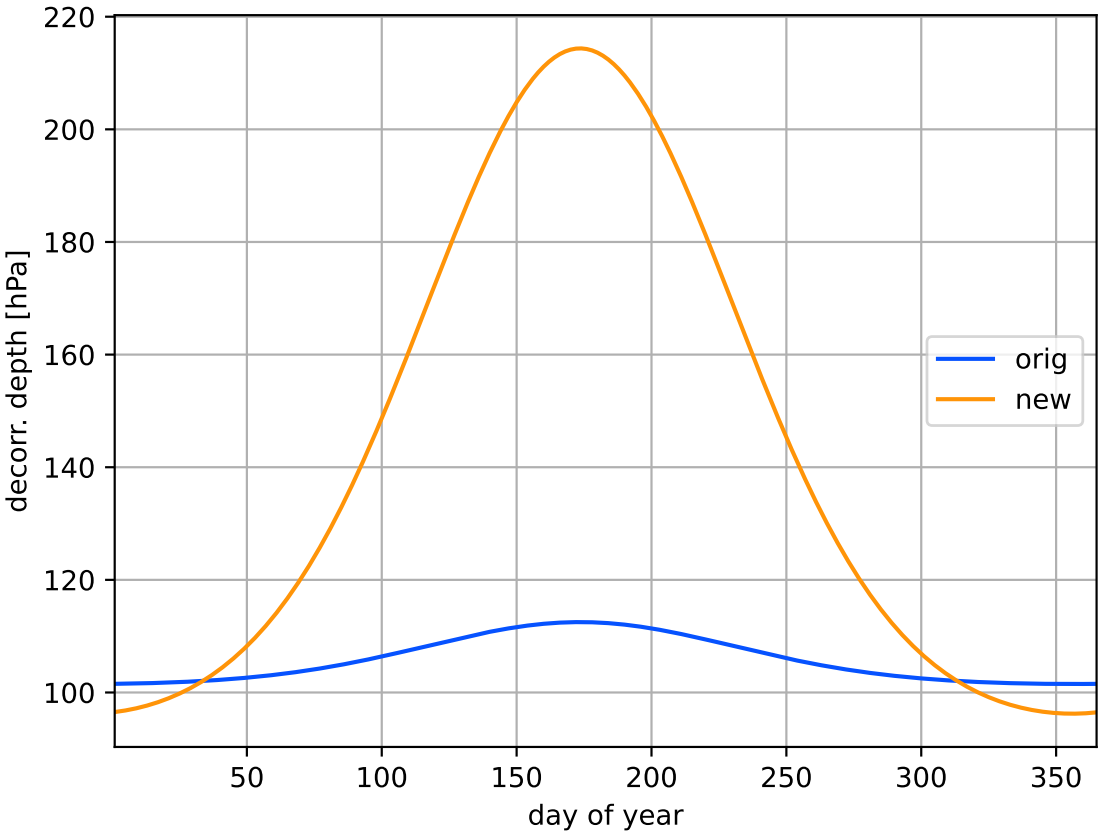
- more physically based (we know Kessler is wrong)
- reduces positive precipitation bias
- better representation of rain shadow
- reduction of precipitation maxima in convection
- target: introduce Lopez evaporation while keeping good (surface) scores
- we adjusted clouds in radiation, microphysics, and condensation

Radiation changes

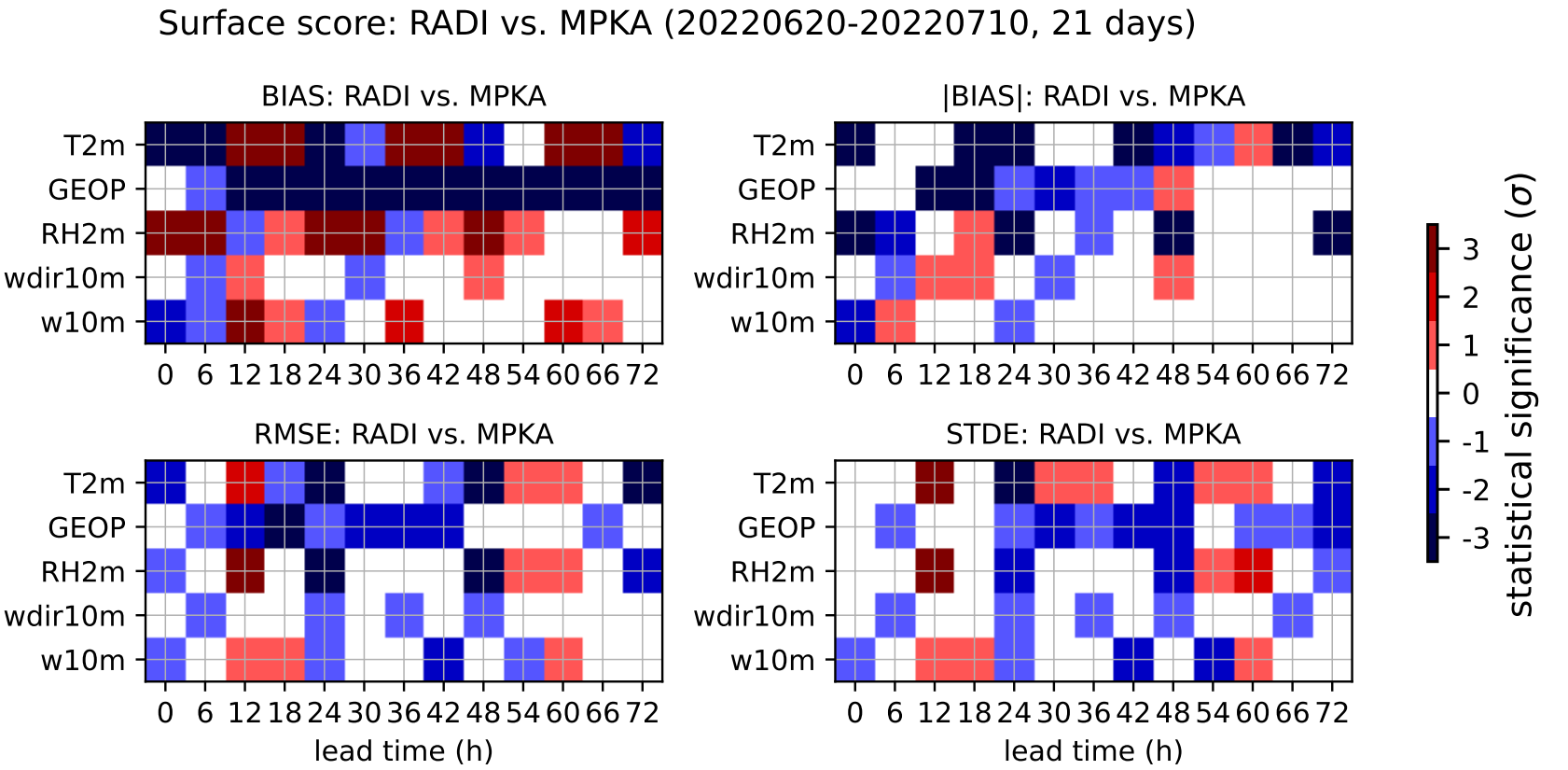
- more restrictive vertical profile of HU_c
- more pronounced yearly cycle of exponential-maximum-random overlap
  - decorrelation length: where max becomes random



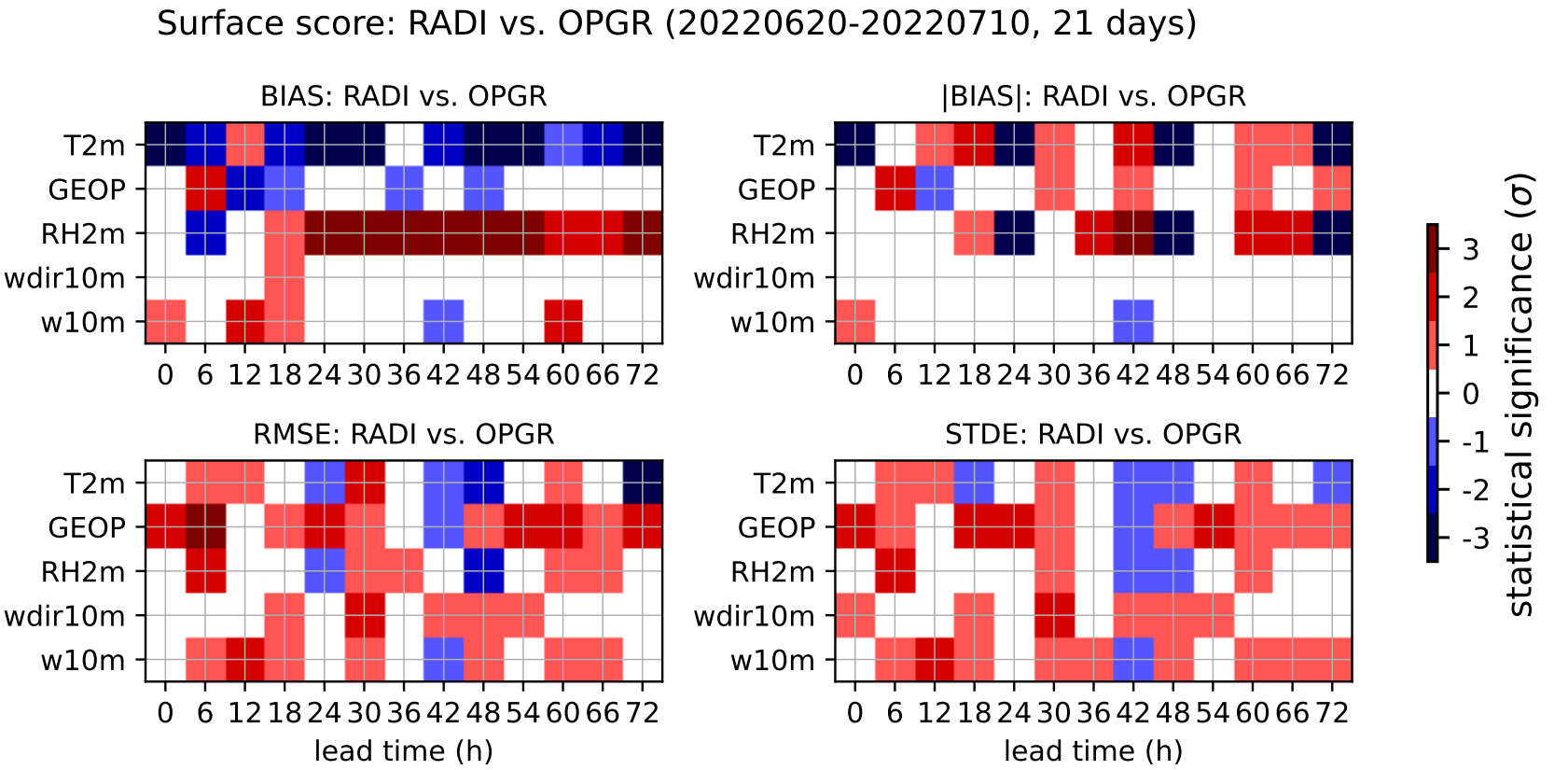
Amplified yearly cycle of decorrelation length



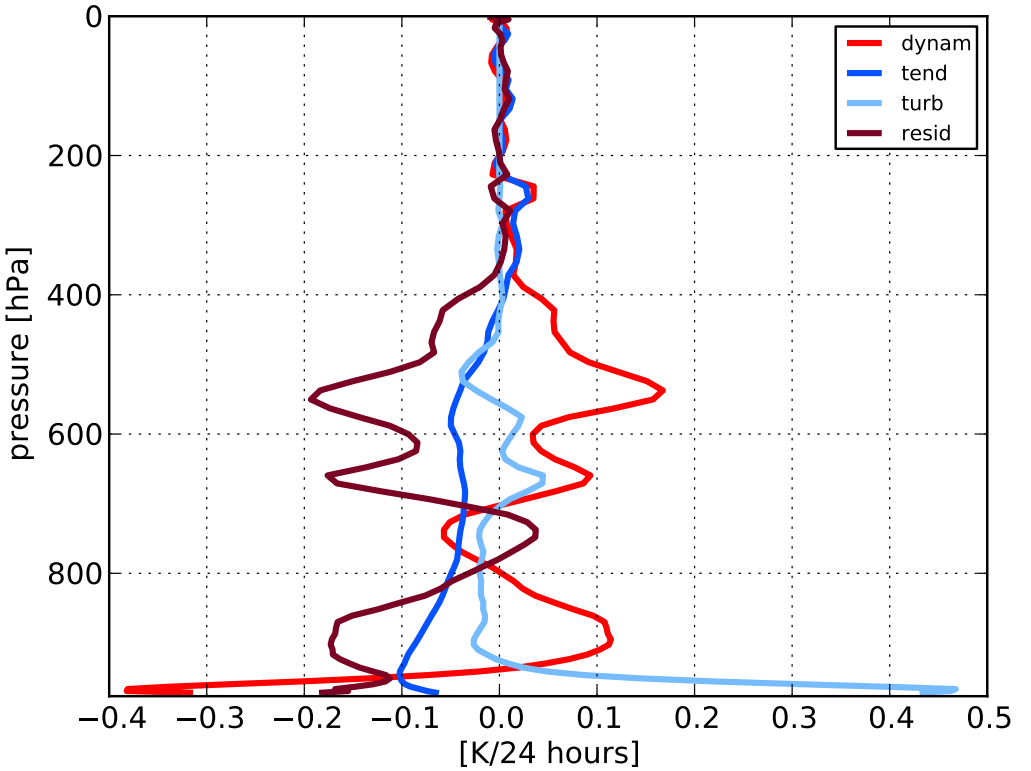
Radiation changes: results vs. without radiation changes



Radiation changes: results vs. operational



Temperature budget difference vs. operational



⇒ changes in microphysics needed

Autoconversion

$$\left(\frac{dq_l}{dt}\right)_{aco} = -k_r q_l \left\{1 - \exp\left[-\frac{\pi}{4}\left(\frac{q_l}{q_l^{crit}}\right)^2\right]\right\} \tag{1}$$

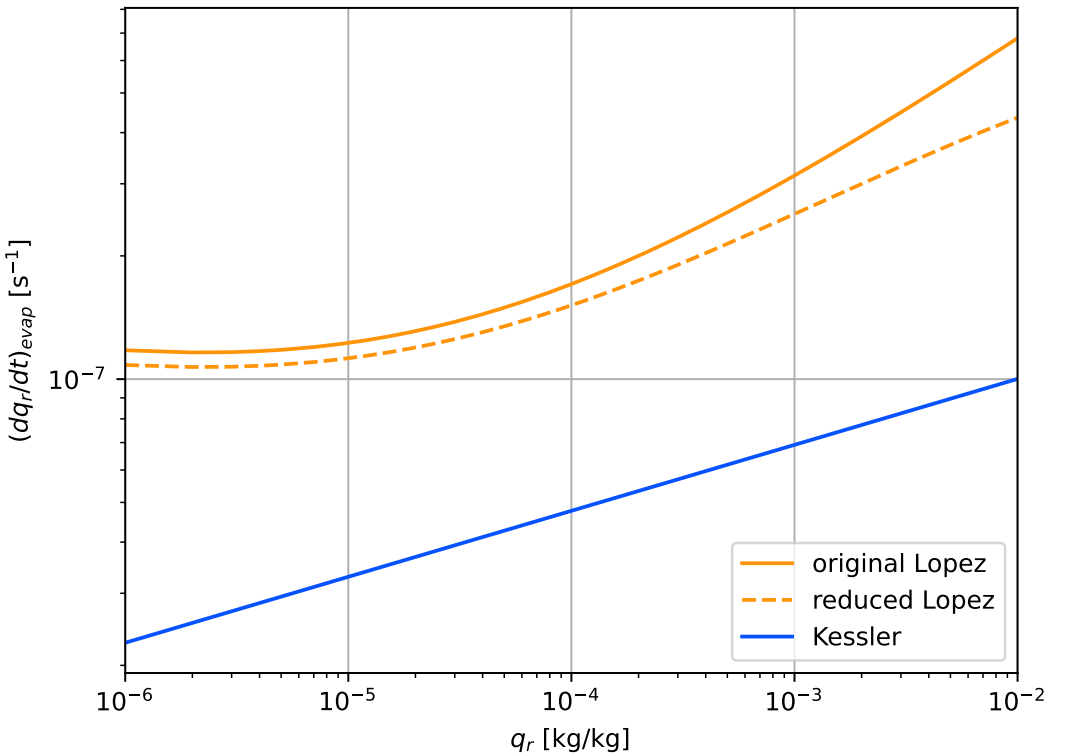
- k_r important mainly for heavy autoconversion rates
  - higher k_r reduces the geopotential bias, warms up lower levels
- q_l^{crit} important for stratus/stratocumulus cases
  - higher compensates for the change of k_r

Reduction of evaporation of rain (1/2)

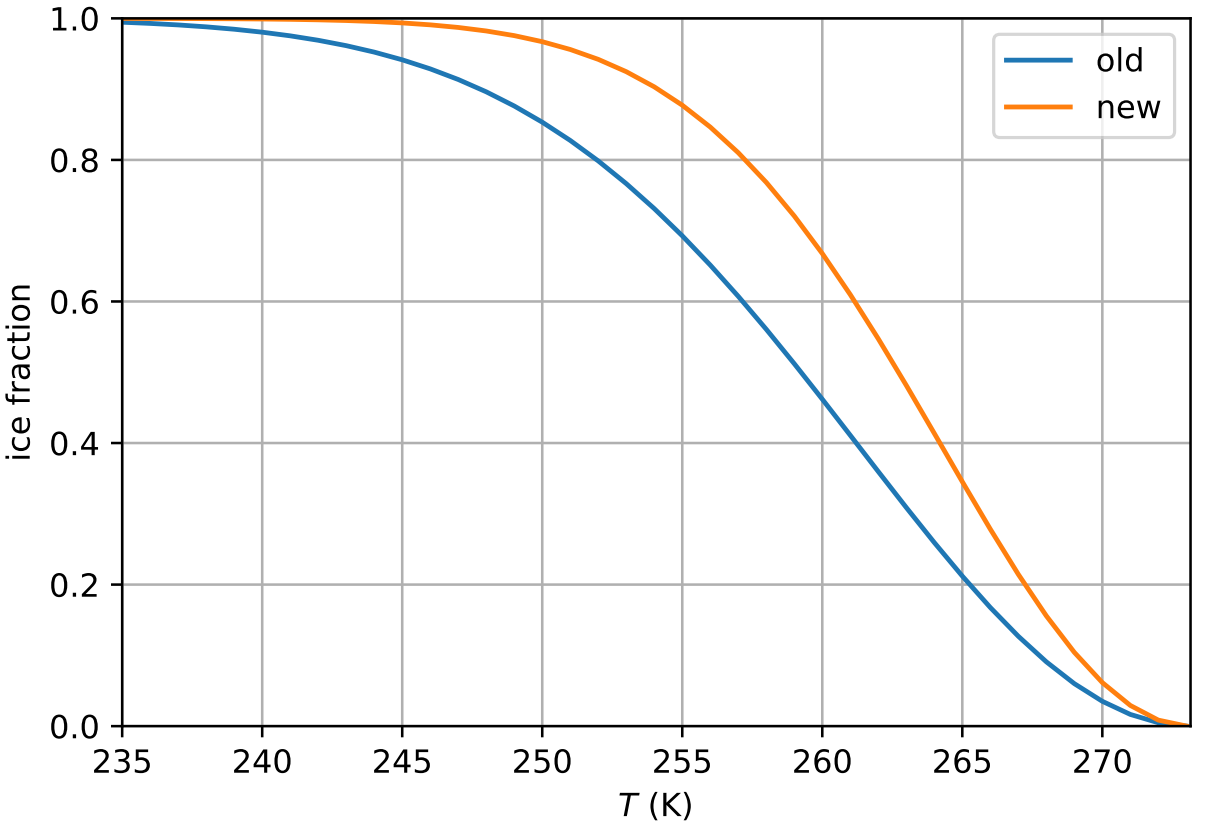
$$\left(\frac{dq_j}{dt}\right)_{evap,new} = \left(\frac{dq_j}{dt}\right)_{evap} \left[1 - e^{-\frac{\sum_i \left(\frac{dq_i}{dt}\right)_{evap}}{c_j}}\right] \frac{c_j}{\sum_i \left(\frac{dq_i}{dt}\right)_{evap}}, \tag{2}$$

- c_j limits highest evaporation rates of hydrometeor category j
- we use it only for rain, $c_r = 7 \cdot 10^{-7}\,\mathrm{kg} \cdot \mathrm{kg}^{-1} \cdot \mathrm{s}^{-1}$

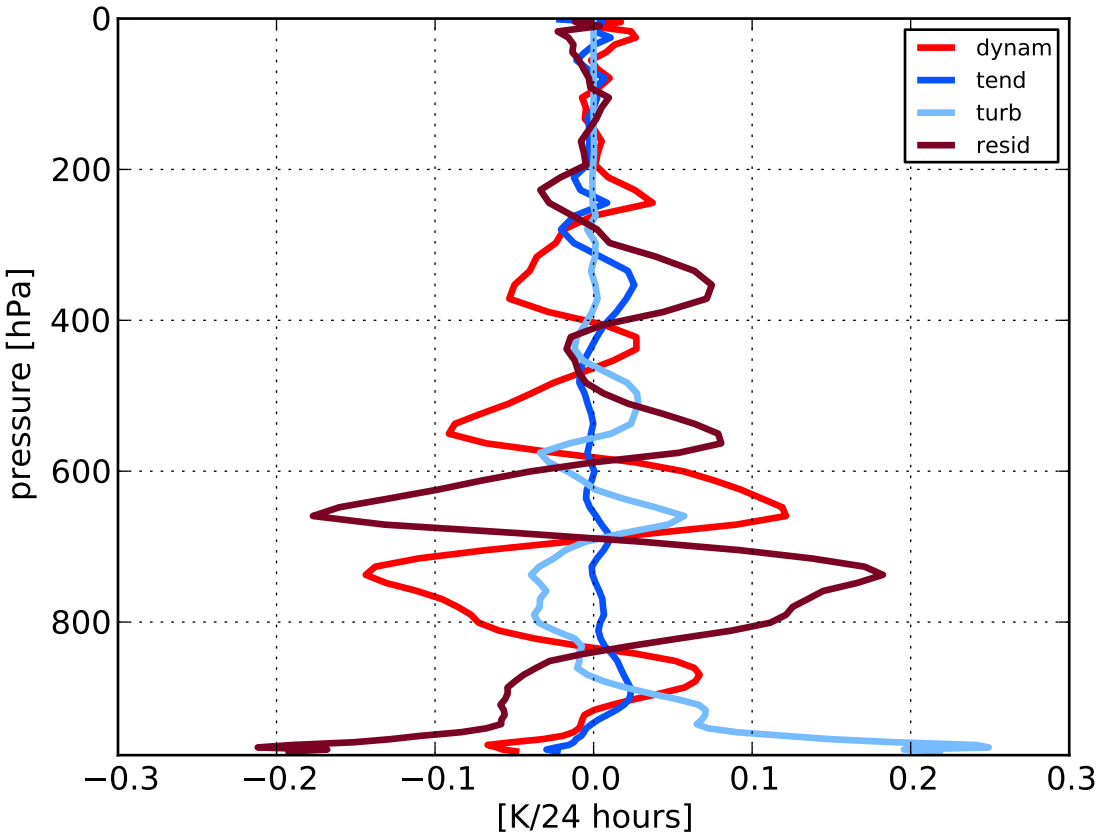
Reduction of evaporation of rain (2/2)



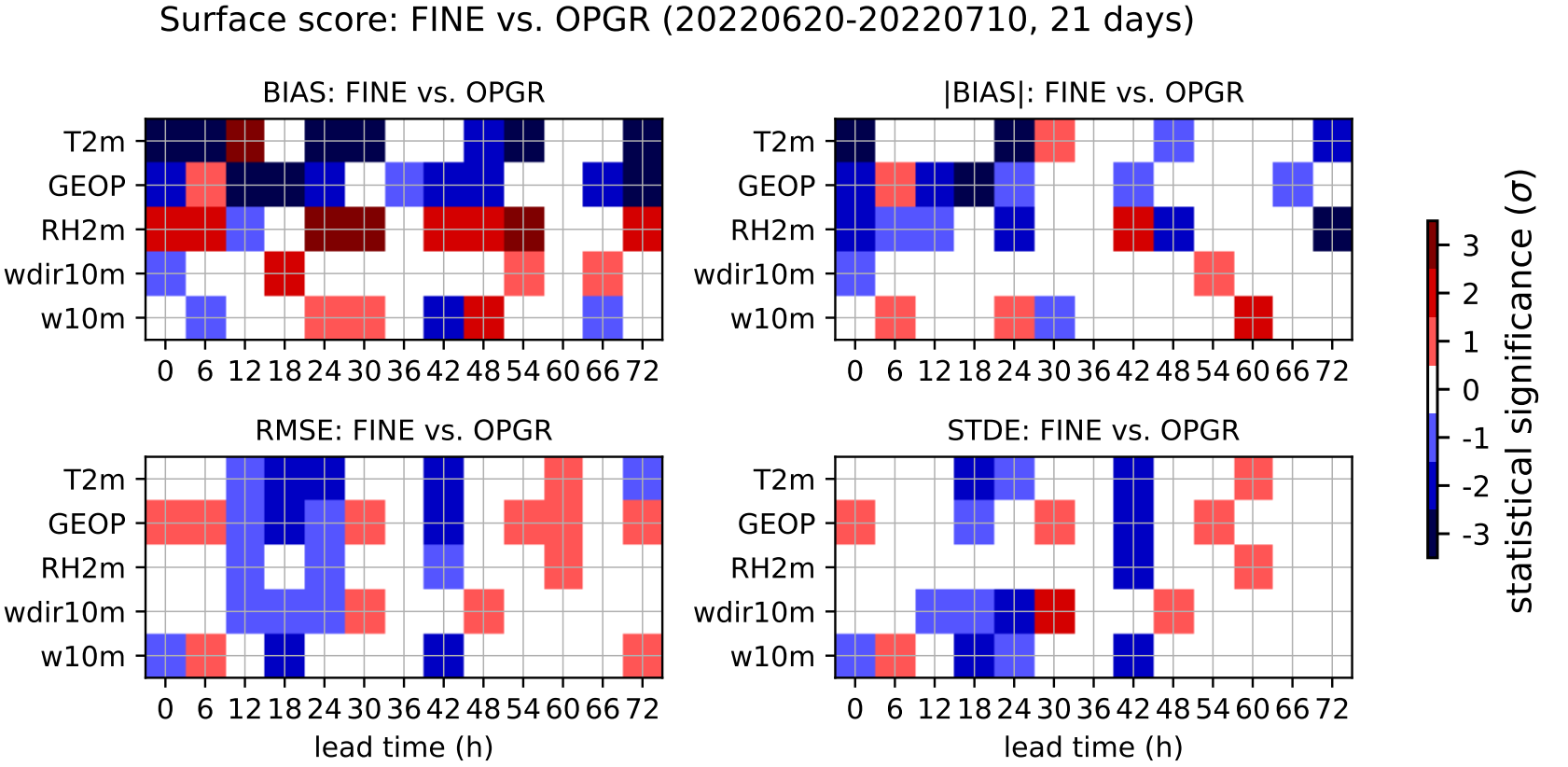
Different split between phases in condensation



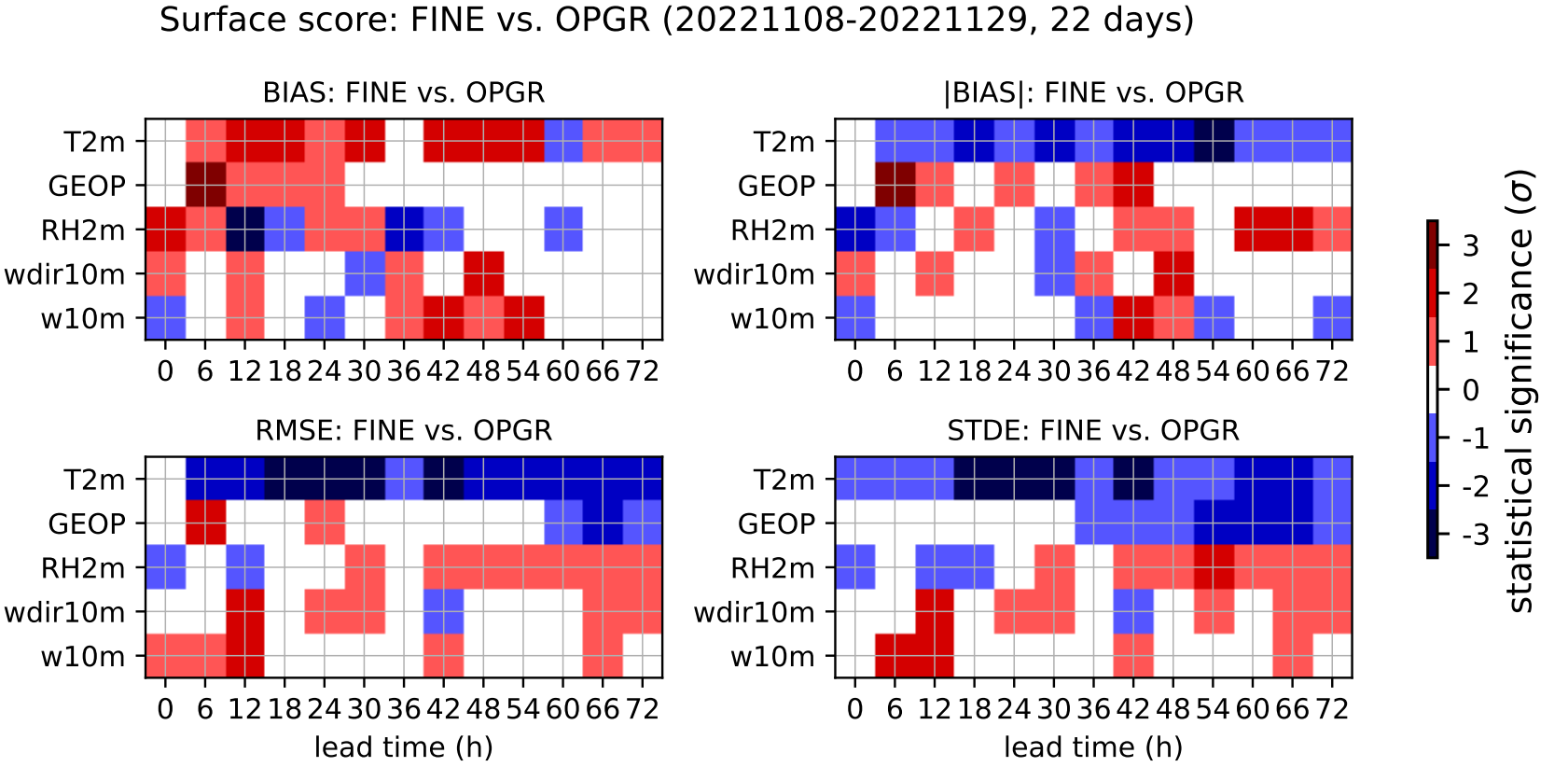
Results: fixed split between dynamics and turbulence



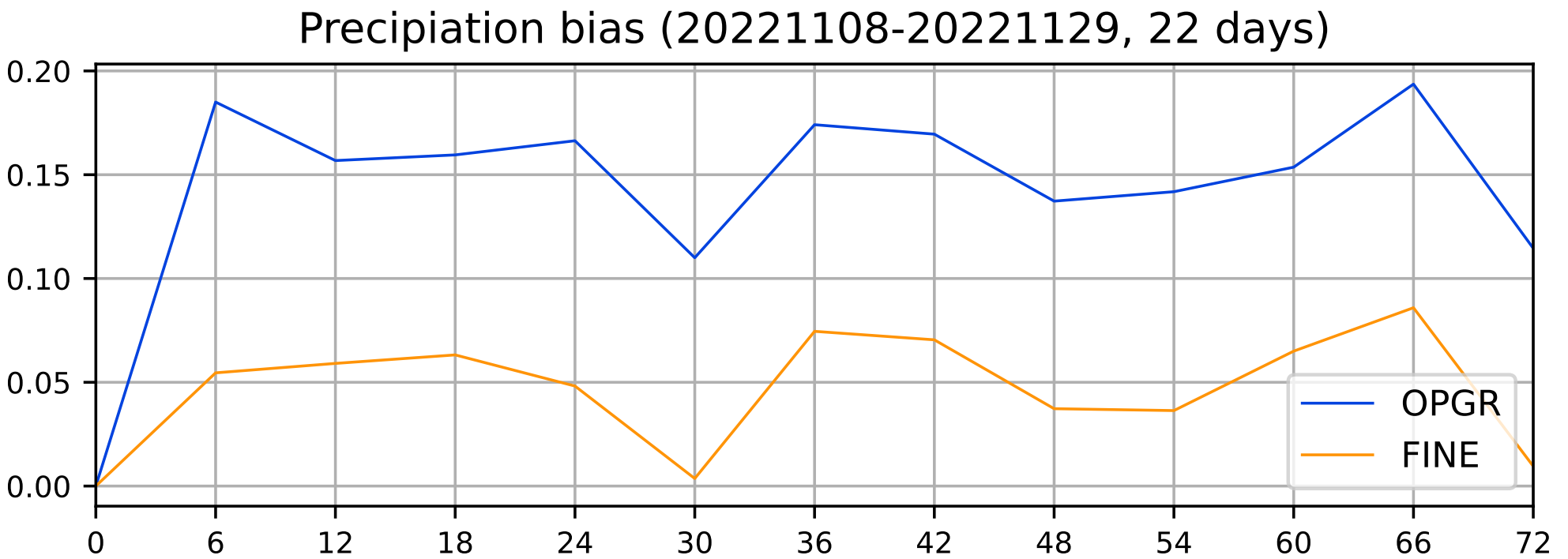
Results: scores in summer



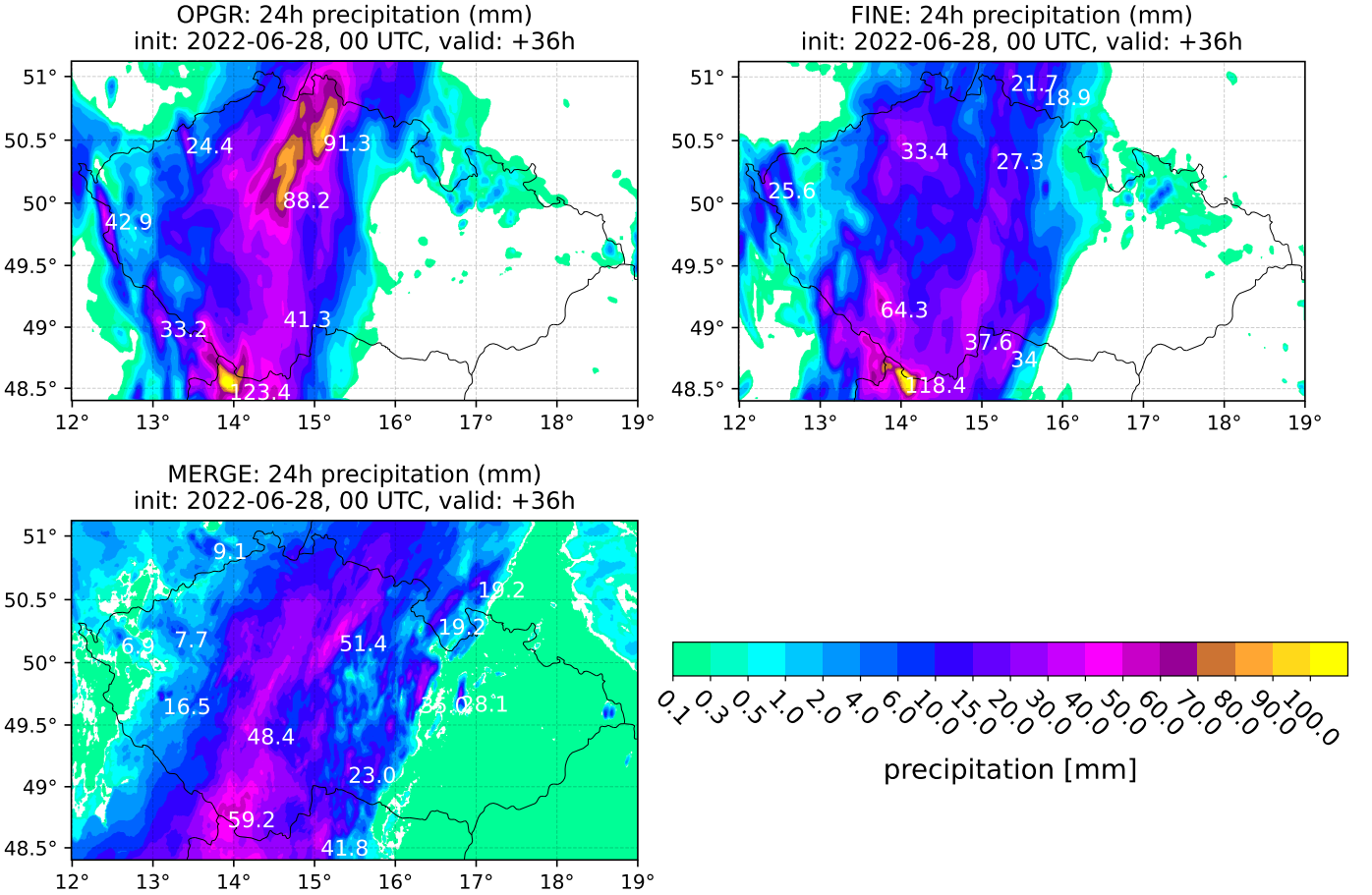
Results: scores in autumn



Results: precipitation bias in autumn



Results: precipitation in convection



Conclusion

- benefit of lower precipiation bias kept while scores are neutral
- big influence of yearly cycle of the decorrelation length and reduction of evaporation
- microphysics changes with Lopez evaporation scheme is now operational

Thank you for your attention

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